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Sir:

Transmitted herewith for filing is the patent application of

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SAKAMOTO, Tomohiro

For: SOLID-STATE IMAGE PICKUP APPARATUS CAPABLE OF READING OUT
IMAGE SIGNALS WHILE THINNING THEM DOWN HORIZONTALLY AND
SIGNAL READING METHOD THEREFOR

Enclosed are:

- X A specification consisting of 25 pages
- X 6 sheet(s) of Formal drawings
- X An assignment of the invention
- X Certified copy of Priority Document(s)
- X Executed Declaration X Original Photocopy
- A verified statement to establish small entity status under 37
CFR 1.9 and 37 CFR 1.27
- Preliminary Amendment
- X Information Disclosure Statement, PTO-1449 and reference(s)

Other

The filing fee has been calculated as shown below:

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FOR	NO. FILED	NO. EXTRA	RATE FEE		RATE FEE
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TOTAL CLAIMS	6 - 20 =	0	x18 =\$ 0.00	or	x 9 = \$ 0.00
INDEPENDENT	2 - 3 =	0	x78 =\$ 0.00	or	x 39 = \$ 0.00
MULTIPLE DEPENDENT CLAIM PRESENTED <u>no</u>			+260 = \$ 0.00	or	+130 = \$ 0.00
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Please charge Deposit Account No. 02-2448 in the amount of \$_____. A triplicate copy of this transmittal form is enclosed.

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Respectfully submitted,

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TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT we, ATSUHIKO ISHIHARA, residing in Asaka-shi, Saitama, Japan and TOMOHIRO SAKAMOTO, residing in Miyagi, Japan, respectively, both citizens of Japan, have invented certain new and useful improvements in SOLID-STATE IMAGE PICKUP APPARATUS CAPABLE OF READING OUT IMAGE SIGNALS WHILE THINNING THEM DOWN HORIZONTALLY AND SIGNAL READING METHOD THEREFOR of which the following is a specification.

SOLID-STATE IMAGE PICKUP APPARATUS CAPABLE OF READING OUT
IMAGE SIGNALS WHILE THINNING THEM DOWN HORIZONTALLY
AND SIGNAL READING METHOD THEREFOR

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BACKGROUND OF THE INVENTION

Field of the Invention

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The present invention relates to a solid-state image pickup
10 apparatus capable of reading out images signals while thinning
them down in the horizontal direction, and a signal reading
method therefor. More particularly, the present invention
relates to a solid-state image pickup apparatus capable of
processing image signals representative of, e.g., a scene picked
15 up and outputting the processed image signals while using the
image signals for a control purpose. The present invention
is desirably applicable to, e.g., a digital still camera, image
input apparatus or similar imaging apparatus of the type
automatically adjusting a focus and an exposure with image
20 signals representative of a scene picked up.

Description of the Background Art

An imaging apparatus of the type described includes an
image pickup section having CCDs (Charge Coupled Devices) or
25 similar photosensitive devices each forming a single pixel or
cell. Today, the number of pixels required of the image pickup
section is increasing to meet the increasing demand for higher
image quality. This, however, increases a period of time
necessary for image signals to be read out of the image pickup
30 section.

Japanese patent laid-open publication No. 136244/1998,
for example, teaches an electronic image pickup apparatus capable
of reducing the above period of time for driving an image pickup

section. The image pickup apparatus taught in this document implements the display of a movie with a drive frequency of less than 20 MHz despite that it uses an image sensor having about 1,000,000 CCDs. Specifically, the apparatus uses color filters arranged in a Bayer pattern in combination with the CCD image sensor. In a high speed mode, the apparatus drives the image pickup section in such a manner as to output one line of image signals every three lines, i.e., to thin down the lines in the vertical direction. This is successful to read image signals at a high speed with a low drive frequency. Particularly, when automatic focus (AF) adjustment, automatic white balance (AWB) adjustment and automatic exposure (AE) adjustment are effected during movie display, control data is required frame by frame. In this case, the apparatus selects a mode for adding three consecutive lines of signals and outputting the resulting sum. In this manner, to reduce the signal reading time, the apparatus thins down the lines in the vertical direction. For the AF, AWB and AE adjustment, the apparatus adds up three consecutive lines of signal charges in order to produce a control signal, i.e., reads all of the three primary colors R (red), G (green) and B (blue) separated by the color filters and then combines them.

As for the generation of control data for AE and AF, a luminance signal plays an important role, as well known in the art. In addition, in a solid-state image pickup apparatus, only the color G contributes to the generation of a luminance signal, as also generally accepted. For photometry, therefore, only the color G may be read out in order to promote effective signal reading. However, it is difficult with the Bayer arrangement to read only the color G because the colors R, G and B exist together in an array.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a solid-state image pickup apparatus capable of reading only the color G and eventually reducing a period of time necessary for signal charges to be transferred in the horizontal direction, and a signal reading method therefor.

A solid-state image pickup apparatus of the present invention includes an image pickup section. The image pickup section includes a color separating section having color filters assigned to three primary colors R, G and B for separating colors of light incident from a desired scene. The color filters assigned to the color G are arranged in stripes. A plurality of photosensitive cells are arranged bidimensionally in one-to-one correspondence to the color filters each for transforming light output from a particular color filter to a corresponding signal charge. A plurality of vertical transfer paths each have transfer elements vertically arranged for vertically transferring signal charges fed from the adjoining photosensitive cells. A horizontal transfer path perpendicular to the vertical transfer paths has transfer elements horizontally arranged for transferring the signal charges fed from the vertical transfer paths. Signal reading circuitry shifts the signal charges from the photosensitive cells to the vertical transfer paths. Charge sweeping circuitry sweeps out needless ones of the signal charges stored in the photosensitive cells. A mode selecting section selects, when the operation for reading the signal charges out of the image pickup section is represented by a mode, either one of an all pixel read mode for reading the signal charges from all of the photosensitive devices and a particular pixel read mode for reading only the signal charges representative of the color G. A drive signal generating section feeds horizontal and vertical drive signals to the image pickup section, and provides the horizontal drive signals with a period shorter in the particular pixel read mode than in the all pixel

read mode. A controller controls the drive signal generating section in a particular manner in each of the all pixel read mode and particular pixel read mode.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and features of the present invention will become more apparent from the consideration of the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a block diagram schematically showing a solid-state image pickup apparatus embodying the present invention;

FIG. 2 is a schematic block diagram showing a specific configuration of an image pickup section included in the illustrative embodiment;

FIG. 3 is a schematic block diagram showing a specific configuration of an H (horizontal) driver also included in the illustrative embodiment;

FIG. 4 is a diagram showing a relation between electrodes arranged on a horizontal transfer path included in the image pickup section of FIG. 2 and horizontal drive signals applied thereto;

FIGS. 5A-5I are timing charts representative of a specific relation between drive signals fed from the H driver of FIG. 3 in a still picture shoot mode and a photometry control mode available with the illustrative embodiment;

FIG. 6A is a view showing another specific configuration of the image pickup section;

FIG. 6B shows color signals R, G and B read out of the image pickup section of FIG. 6A in a specific sequence; and

FIG. 6C shows the color signals G read out of the image pickup section of FIG. 6A in the photometry control mode.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Briefly, to read image signals at a high speed, the present

invention replaces the conventional thinning of lines in the vertical direction with thinning in the horizontal direction. For this purpose, in accordance with the present invention, a color pattern output from a color separating section and horizontal drive signals output from a drive signal generating section are fed to an image pickup section in order to implement a particular pixel read mode different from the conventional all pixel read mode. It is to be noted that structural elements not relevant to the understanding of the present invention are not shown or described, and that reference numerals attached to various signals correspond to reference numerals designating connection lines on which the signals appear.

Referring to FIG. 1 of the drawings, a solid-state image pickup apparatus embodying the present invention is shown and implemented as a digital still camera by way of example. As shown, the digital still camera, generally 10, is generally made up of an image pickup section 10A, a signal processing section 10B, a signal output section 10C, a drive signal generating section 10D, a system controller 12, and a release shutter 14. The image pickup section 10A includes a lens 102, an AF adjustment 104 including a focusing mechanism, not shown, an AE adjustment 106 including a stop mechanism, not shown, and an image pickup 108. If desired, a shutter mechanism, not shown, may be positioned in front of the image pickup 108 in the direction light incidence in order to fully intercept light.

The lens 102 focuses incident light representative of a scene on the photosensitive surface of the image pickup 108. The AF adjustment 104 moves the lens 102 to an optimal position matching with information output from the focusing mechanism and representative of a range between a desired subject and the camera 10. At this instant, the system controller 12 processes the range information and determines the optimal

position of the lens 102. More specifically, the system controller 12 feeds a control signal 12a to the AF adjustment 104. In response, the AF adjustment 104 drives its focusing mechanism with a drive signal 104a so as to move the lens 102 to an optimal focal position.

The system controller 12 includes an exposure control circuit, not shown, for calculating the photometric value of the scene including the subject. The AE adjustment 106 adjusts, under the control of the exposure control circuit, an iris diaphragm included in the stop mechanism, thereby restricting an incident beam to an optimal quantity. In the illustrative embodiment, photometry is implemented by part of image signals. The system controller 12 calculates an exposure and feeds a control signal 12b representative of the exposure to the AE adjustment 106. In response, the AE adjustment 106 delivers a drive signal 106a to each of the stop mechanism and shutter mechanism for setting up an optimal exposure indicated by the control signal 12b.

FIG. 2 shows a specific configuration of the image pickup 108. As shown, the image pickup 108 has photosensitive cells or photoelectric transducers 108a arranged bidimensionally in rows and columns. The photosensitive cells 108a each transform incident light to a corresponding electric signal or signal charge. Color filters for color separation, not shown, each are positioned in front of a particular photosensitive cell 108a in the direction of light incidence. The color filters are implemented as a single plate and arranged such that, e.g., three primary colors R, G and B separated by the filters are selectively input to the photosensitive cells 108a, as indicated by letters R, G and B in FIG. 2. The arrangement of the colors R, G and B shown in FIG. 2 is generally referred to as a G vertical stripe, RB full checker pattern.

5 The image pickup 108 receives a control signal 12c from the system controller 12 and receives drive signals 12B from the drive signal generating section 10D which will be described later specifically. The photosensitive cells 108a are implemented by CCDs. As shown in FIG. 2, transfer gates or signal read gates 108b each are connects between one photosensitive cell 108a and a vertical transfer path 108c adjoining the cell 108a, preventing a signal charge 14a stored in the cell 108a from leaking. Specifically, the transfer gates 108b transfer signal charges 14a stored in the associated photosensitive cells 108a to the vertical transfer paths 108c adjoining the cells 108a in response to field shift pulses not shown. The field shift pulses are fed to the transfer gates 108b via electrodes not shown.

15 The drive signals 12B fed from the drive signal generating section 10D to the image pickup 108, as mentioned earlier, are made up of vertical drive signals 100a and horizontal drive signals 100b which will be described specifically later. Each vertical transfer path 108c sequentially transfers, in accordance with the vertical drive signals 100a, the signal charges 14a read out of the adjoining photosensitive cells 108a via the transfer gates 108b in the direction of columns, i.e., vertically as indicated by arrows 14b in FIG. 2. As shown in FIG. 2, the signal charges 14a transferred vertically downward along the transfer paths 108c are handed over to a horizontal transfer path 108d. The horizontal transfer path 108d transfers the signal charges 14a horizontally to the signal processing section 10B via an amplifier 108e in accordance with the horizontal drive signals 100b.

As shown in FIG. 1, the signal processing section 10B includes an ADC (Analog-to-Digital Converter) 110, a signal processing 112, and a buffer 114. The ADC 110 converts the

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analog image signals, or signal charges, 14a output from the image pickup 108 to digital image data 14c in accordance with a control signal 12d fed from the system controller 12 and a clock signal, not shown, fed from a clock generation 116 which will be described specifically later. The signal processing 112 executes white balance correction, gamma correction, aperture correction and other conventional correction with the digital data 14c input thereto from the ADC 110. Subsequently, the signal processing 112 processes the corrected digital data in accordance with either one of two different modes selected via the release shutter 14. The two modes are a still picture shoot mode for storing at least a still picture picked up in a recording device 130 included in the signal output section 10C, and a photometry control mode or preshooting mode for simply controlling the AE mechanism and AF mechanism of the image pickup section 10A.

The system controller 12 feeds a control signal 12e representative of the above still picture shoot mode or the photometry control mode currently selected on the camera 10 to the signal processing 112. In the still picture shoot mode, the corrected image data 14d are subjected to compression or similar preselected modulation under the control of the system controller 12. In the photometry control mode, the image signals 14a are read out of the image pickup 108 at a rate, e.g., two times higher than the conventional reading rate under the control of the system controller 12. In addition, the image signals 14a are thinned down in the vertical direction, so that they can be displayed on a display 132 also included in the signal output section 10C. The compression or similar modulation effected by the image processing 112 in the still picture shoot mode transforms the image signals 14a to video signals capable of being written to the recording device 130. The signal processing 112 delivers only the image data 14d to be displayed

or recorded to the buffer 114.

5 The system controller 12 controlling the entire camera 10 receives a signal 12f from the release shutter 14 and determines which of the still picture shoot mode and photometry control mode is selected by the operator. The system controller 12 controls the drive signal generating section 10D on the basis of the result of the above decision. The system controller 12 includes a record control 12A. The record control 12A controls the buffer 114 and the recording device 130 of the signal output section 10C in accordance with a timing signal output from the system controller 12.

15 The drive signal generating section 10D includes a clock generation 116 and a timing signal generation 118. The system controller 116 feeds a control signal 12j to the clock generation 116 and causes it to generate a synchronizing signal 16a. The synchronizing signal 16a is derived from an original oscillation clock causing the camera 10 to operate with an NTSC (National Television System Committee) system or a PAL (Phase Alternation by Line) system. The synchronizing signal 16a is fed from the clock generation 116 to the signal processing 112 and timing signal generation 118. In addition, the clock generation 116 delivers a particular clock to each of the ADC 110 and buffer 114 as a sampling signal or a write/read enable signal.

25 The timing signal generation 118 outputs, in accordance with the synchronizing signal 16a, various timing signals including a vertical timing signal 118a and a horizontal timing signal 118b as well timing signals, not shown, for effecting a field shift and a line shift. The vertical timing signal 118a and horizontal timing signal 118b are respectively applied to a V (vertical) driver 120 and an H (horizontal) driver 122 for driving the vertical transfer paths 108c and horizontal

transfer path 108d, FIG. 2. The V driver 120 and H driver 122 respectively output the previously mentioned drive signals 100a and 100b in accordance with the timing signals 118a and 118b. Generally, the vertical drive signals 100a output from the V driver 120 are switched in accordance with the mode selected in order to adjust the signal reading rate. The timing signal generation 118 additionally outputs timing signals, not shown, for controlling the AF adjustment 104 and AE adjustment 106.

When the system controller 12 delivers a control signal 12g indicative of the photometry control mode to the timing signal generation 118, the generation 118 causes the substrate voltages, i.e., overflow-drain (OFD) voltages of the photosensitive devices 108a assigned to the colors R and B to rise. This will be described more specifically later. Generally, the signal reading rate is adjusted also by the vertical drive signals 100a output from the V driver 120 in accordance with the mode selected.

In the illustrative embodiment, not only the V driver 120 but also the H driver 122 are switched in accordance with the mode selected. FIG. 3 shows a specific configuration of the H driver 122. As shown, the H driver 122 is made up of four H drivers 122a, 122b, 122c and 122d and a mode adaptive selector 122e. Voltages of 12 V and 5 V are applied to the H drivers 122a and 122c, respectively. The outputs of the H drivers 122a and 122c are dependent on the level of a horizontal timing signal H1 input to the H drivers 122a and 122c. The horizontal timing signal H1 corresponds to the horizontal timing signal 118b, FIG. 1; the label H1 is used to adequately show the feature of the signal. Voltages of 8 V and 1 V are applied to the H drivers 122b and 122d, respectively. An inverter 122f inverts the horizontal timing signal H1 to thereby output an inverted horizontal timing signal H2 and feeds the signal H2 to the H

drivers 122b and 122d. The outputs of the H drivers 122b and 122d are dependent on the level of the horizontal timing signal H2. It follows that the outputs H1S and H3S of the H driver 122a and the outputs H2S and H4S of the H driver 122c each have an amplitude between 12 V to 5 V, and that the outputs H1B and H3B of the H driver 122b and the outputs H2B and H4B of the H driver 122d each have an amplitude between 8V to 1V.

The system controller 12 feeds a control signal 12h to the H driver 122 in accordance with the mode selected. The H driver 122 causes the mode adaptive selector 122e to output a signal level dependent on the control signal 12h. Specifically, the mode adaptive selector 122e has four switches S10, S12, S14 and S16. The control signal 12h causes the selector 122e to select the output signals H2S and H4S of the H driver 122c and the output signals H1B and H3B of the H drivers 122b in the still picture shoot mode or select the output signals H1S and H3S of the H driver 122a and the output signals H2B and H4B of the H driver 122d in the photometry control mode. FIG. 3 shows one of such two conditions matching with the photometry control mode for reading only the color G. The eight signals H1S-H4S and H1B-H4B each are fed to two of sixteen electrodes E1-E16 shown in FIG. 4. The electrodes E1-E16 each are associated with a particular transfer element of the horizontal transfer path 108d, FIG. 2.

Referring again to FIG. 1, the buffer 114 included in the signal processing section 10B has a function of amplifying the video signal 14d output from the signal processing 112 to a preselected amplitude and a function of adjusting a period of time at the time of recording as well as other functions. The buffer 114 outputs a video signal 14e representative of an image to the signal output section 10C in accordance with a control signal 12i output from the record control 12A of the system

controller 12.

5 The recording device 130 of the signal output section 10C includes a semiconductor memory applicable to, e.g., a memory card, an optical recording medium, a magnetoptical recording medium or similar recording medium not shown. The recording device 130 records the video signal 14e in the recording medium in accordance with a control signal 12k output from the record control 12A. The recording device 130 is capable of reading the video signal 14e out of the recording medium and display it on the display 132, as desired. If the recording medium is removable from the recording device 130, then the medium may be removed and mounted to an apparatus for reproducing a video signal or printing out an image.

15 The illustrative embodiment allows the operator to press the release shutter 14 stepwise to either one of two positions, i.e., a half-pressed position and a full-pressed position. In the half-pressed position, the release shutter 14 selects the photometry control mode and sends the signal 12f representative of the mode to the system controller 12. In the full-pressed position, the release shutter 14 provides the system controller 12 with an image pickup timing while sending the signal 12f representative of the still picture shoot mode to the system controller 12. Further, if the power supply to the release shutter 14 is set up and if a monitor switch, not shown, mounted on the camera 10 is turned on, the system controller 12 causes the display 132 to operate in a movie mode.

30 The operation of the digital camera 10 having the above configuration will be described hereinafter. First, the operator intending to shoot a desired scene presses the release shutter 14 to the half-pressed position assigned to the photometry control mode. In this stage of operation, among the color

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signals R, G and B produced by the image pickup 108, only the color signal G is read out under the control of the system controller 12. This is effected at a high speed in accordance with the drive signals 12B, as will be described specifically later. The resulting image signals 14a output from the image pickup 108 are fed to the signal processing section 10B in accordance with the control signal 12c output from the system controller 12. The signal processing section 10B digitizes the image signals 14a and delivers the resulting image data 14c to the system controller 12 as photometry data via a signal line not shown.

The system controller 12 performs calculation with the above photometry data so as to produce the control signals 12a and 12b for AF adjustment and AE adjustment, respectively. The control signals 12a and 12b are respectively fed to the AF adjustment 104 and AE adjustment 106, as stated earlier. In response, the AF adjustment 104 and AE adjustment 106 each perform particular adjustment by use of the respective mechanism. The AF adjustment and AE adjustment are repeated so long as the photometry control mode is selected.

The operator presses the release shutter 14 deeper to the full-pressed position assigned to the still picture shoot mode at any desired time for shooting the scene. In response, the release shutter 14 feeds the signal 12f for recording the scene to the system controller 12. As a result, the image pickup section 10A picks up light incident from the scene in the same manner as in the photometry control mode. In the still picture shoot mode, however, the image pickup 108 executes processing for outputting all of the three color signals R, G and B. This is, of course, done by drive signals different from the drive signals used in the photometry mode. The resulting image signals 14a are digitized by the ADC 110 and then fed to the signal

processing 112 as the digital data 14c. The signal processing
112 processes the digital data 14c in such a manner as to further
extend their frequencies to the high frequency side.
Subsequently, the signal processing 112 executes compression
5 and other conventional processing with the digital data 14c
and delivers the processed data to the signal output section
10C via the buffer 114. In the still picture shoot mode, the
signal output section 10C writes the input image data in the
recording device 132 in accordance with the control signal 12k
10 output from the record control 12A. The recording device 132
is, of course, capable of reading the recorded image data in
accordance with the control signal 12k, as stated previously.

The drive signal generating section 10D is so constructed
15 as to adapt to both of the photometry mode and still picture
shoot mode, as stated earlier. Reference will be made to FIGS.
3 and 5A-5I for describing the operation of the H driver 122.
As shown in FIG. 3, the horizontal timing signal H1 is applied
to the H drivers 122a and 122c while the horizontal timing signal
20 H2 is applied to the H drivers 122b and 122d.

In the still picture shoot mode, the image pickup 108
receives the previously mentioned OFD voltages for determining
the signal charge storing capacities of the photosensitive cells
25 108a, and a transfer gate timing signal, not shown, for effecting
the field shift of signal charges from the photosensitive cells
108a to the vertical transfer paths 108c via the transfer gates
108b. Specifically, the signal charges 14a stored in the
photosensitive cells 108a are transferred to the associated
30 vertical transfer paths 108c in response to the transfer gate
timing signal. The vertical transfer paths 108c sequentially
transfer the signal charges 14a toward the horizontal transfer
path 108d in synchronism with the vertical drive signals 100a
fed from the V driver 120 to their transfer elements. The signal

charges 14a reached the ends of the vertical transfer paths 108c are handed over to the horizontal transfer path 108d. Thereafter, the horizontal timing signal H1 is fed to the horizontal transfer path 108d.

5

In the still picture shoot mode, the signal charges are sequentially input to the horizontal transfer path 108d in the order of G, R/B, G, R/B, G and so forth by way of example, as shown in FIG. 5A. FIG. 5A shows the R, G and B color pattern at its upper portion and the horizontal drive signal H1 at its lower portion. As shown, the horizontal timing signal H1 having a preselected period is fed to read the signal charges 14a out of the horizontal transfer path 108d by four-phase drive. At the same time, to read out all of the pixels, the H driver 122 combines the horizontal timing signal H1 of FIG. 5A and the inverted horizontal timing signal H2, not shown, and delivers the combined drive signals to the image pickup 108, as shown in FIGS. 5B (drive signal) and 5C (another pattern). Consequently, the signal charges 14a advance one step in the horizontal direction for one period of the above drive signals.

The photometry control mode for reading out only the color G by use of the G vertical stripe, RB full checker pattern will be described hereinafter. In this mode of operation, the drive signal generating section 10D raises, among OFD voltages fed to the image pickup 108, the OFD voltages for the photosensitive cells 108a assigned to the colors R and B. As a result, all the signal voltages derived from the colors R and B are swept out to the substrates. At the same time, the drive signal generating section 10D feeds an OFD voltage allowing an expected amount of signal charge to be stored to the photosensitive cells 108a assigned to the color G. In addition, at the time of field shift following the shot, the transfer gate timing signal is fed only to the transfer gates 108b associated with the color

G. Consequently, only signal charges derived from the color G appear on the vertical transfer paths 108c. These signal charges 14a are transferred to the horizontal transfer path 108d, as stated previously.

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In the illustrative embodiment, the above signal charges representative of the color G and existing on the horizontal transfer path 108d may advance two steps at a time for one period of the drive signals, as follows. In the still picture shoot mode, no signal charges exist in the transfer elements of the horizontal transfer path 108d originally expected to form R/B packets. Such transfer elements are regarded as elements belonging to G regions. Then, the range of each step of the drive signals remaining at a given voltage is doubled. Stated another way, the signals H1S and H1B may, in principle, be considered to represent the same state.

The mode adaptive selector 122e selects, based on the above concept, the signals H1S, H2B, H3S and H4B in place of the signals H1B, H2S, H3B and S4S, respectively, under the control of the control signal 12h. Consequently, the drive signals H1S, H2S, H1B and H2B related to each other as shown in FIGS. 5D-5G are output. At this instant, the drive signals cause the color G selectively obtained, as shown in FIGS. 5H and 5I, to advance two steps corresponding to eight electrodes at a time. That is, the drive signals double the amount of movement by a single drive, compared to the previous all pixel reading. Translating the amount of movement into a period of time, it will be seen that the drive signals have a period only one half of the period of the drive signals fed at the time of all pixel reading. By so transferring the signal charges 14a by two steps at a time, it is possible to thin down the image signals to one half in the horizontal direction. As a result, despite the G vertical stripe, RB full checker pattern, only the signal

charges 14a derived from the color G are read out of the image pickup 108 in half an amount, compared to the amount read out in the still picture shoot mode.

5 If the above horizontal thinning operation is effected at a two times higher speed, the signal charges 14a will be read out at a two times higher speed. This is successful to reduce the horizontal reading period to one-fourth of the horizontal reading period particular to full pixel reading.

10 By the unique drive scheme described above, image data for photometry control are output at a high speed on the basis of the signal charges 14a derived from the color G. The system controller 12 performs calculation with such image data and
15 then executes AF adjustment and AE adjustment described previously. Considering the ever increasing number of pixels, this kind of scheme is particularly desirable when, e.g., AF adjustment uses only a luminance signal. As for AF adjustment using only a luminance signal, the camera 10 is capable of
20 doubling the conventional photometry control speed.

 The above embodiment has concentrated on the G vertical stripe, RB full checker pattern in implementing the rapid read-out of the signal charges 14a in the photometry control mode.
25 Also available for the rapid reading of the signal charges 14a from the horizontal transfer path 108d is a so-called honeycomb type G square lattice, RB full checker or checker pattern. This type of pattern has been proposed to solve a problem that the sensitivity or area of the individual photosensitive cell,
30 for example, decreases due to the increasing number of pixels. Specifically, in the honeycomb type pattern, pixels adjoining each other are shifted from each other by half a pitch in the horizontal and vertical directions.

5 The honeycomb type G square lattice, RB full checker pattern is shown in FIG. 6A specifically. As shown, the photosensitive devices or cells 108a assigned to the colors R, G and B each are shifted by half a pitch from adjoining ones with respect to the center. The honeycomb pattern is the combination of a pattern in which the G cells 108a form a square and a full checker pattern in which the R cells 108a and B cells 108a each diagonally face each other. In this pattern, too, the G cells 108a are arranged in vertical arrays or columns not including the R cells 108a or the B cells 108a. By using this relation effectively, it is possible output the R, G and B color signals to the horizontal transfer path 108d in the still picture shoot mode, as shown in FIG. 6B, or output only the G color signals to the path 108d in the photometry control mode, as shown in FIG. 6C. In FIG. 6B, the color signals R, G and B appear on the path 108d in the order of R, G, B, G, R, G, B and so forth. In FIG. 6C, only the color signals G appear every other pixel. When the signals G of FIG. 6C are read out, or horizontally transferred, at a rate double the rate of the horizontal timing signal assigned to the still picture shoot mode, the total reading time is reduced by the intervals between the color signals G.

25 As stated above, at least in an application in which the photosensitive cells with the color G are arranged in the vertical direction, i.e., in the direction of columns, signal charges of necessary color or colors can be read out in either one of the still picture shoot mode and photometry control mode. That is, the signal charges can be selectively read out even when the number of pixels increases. This insures simple, rapid transfer of signal charges with no consideration given to the order of reading. It follows that processing with data derived from signal charges can be executed more rapidly in the photometry control mode than in the still picture shoot mode.

Assuming that a digital still camera effects photometry control within a given period of time, the above reduction of reading time successfully reduces the load to actually act on the individual mechanism. In addition, the camera 10 reading the signal charges in the above manner is practicable even with a Bayer pattern.

The entire disclosure of Japanese patent application No. 315510/1998 filed on November 6, 1998 and including the specification, claims, accompanying drawings and abstract of the disclosure is incorporated herein by reference in its entirety.

While the present invention has been described with reference to the illustrative embodiment, it is not to be restricted by the embodiment. It is to be appreciated that those skilled in the art can change or modify the embodiment without departing from the scope and spirit of the present invention.

WHAT IS CLAIMED IS:

- 1 1. A solid-state image pickup apparatus comprising:
 an image pickup section comprising:
 a color separating section including color filters assigned
 to three primary colors R (red), G (green) and B (blue) for
5 separating colors of light incident from a desired scene, the
 color filters assigned to the color G being arranged in stripes;
 a plurality of photosensitive cells arranged bidimensionally
 in one-to-one correspondence to said color filters each for
 transforming light output from a particular color filter to
10 a corresponding signal charge;
 a plurality of vertical transfer paths each comprising
 transfer elements arranged in a vertical direction for vertically
 transferring signal charges fed from adjoining ones of said
 plurality of photosensitive cells;
15 a horizontal transfer path perpendicular to said plurality
 of vertical transfer paths and comprising transfer elements
 arranged in a horizontal direction for transferring the signal
 charges fed from said plurality of vertical transfer paths;
 signal reading circuitry for shifting the signal charges
20 from said plurality of photosensitive cells to said plurality
 of vertical transfer paths; and
 charge sweeping circuitry for sweeping out needless ones
 of the signal charges stored in said plurality of photosensitive
 cells;
25 a mode selecting section for selecting, when an operation
 for reading the signal charges out of said image pickup section
 is represented by a mode, either one of an all pixel read mode
 for reading the signal charges from all of said plurality of
 photosensitive cells and a particular pixel read mode for reading
30 only the signal charges representative of the color G;
 a drive signal generating section for feeding horizontal
 and vertical drive signals to said image pickup section, and
 providing said horizontal drive signals with a period shorter

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in said particular pixel read mode than in said all pixel read mode; and

a controller for controlling said drive signal generating section in a particular manner in each of said all pixel read mode and said particular pixel read mode.

2. An apparatus in accordance with claim 1, wherein said color separating section has any one of a G stripe pattern, a G stripe, RB checker pattern and a G stripe, RB full checker pattern in which the color G is arranged in stripes and a full checker pattern in which the color G is arranged in a square lattice while the colors R and B each are diagonally arranged at opposite sides of the color G.

3. An apparatus in accordance with claim 1, wherein said horizontal drive signals output from said drive signal generating section comprise:

first horizontal drive signals different in phase from each other and assigned to said all pixel read mode and equal in number to electrodes to which said drive signals are fed in said all pixel read mode; and

second horizontal drive signals different in phase from each other and assigned to said particular pixel read mode and two times greater in number than the electrodes used in said all pixel read mode.

4. An apparatus in accordance with claim 3, wherein said second horizontal drive signals have a period which is one half of a period of said first horizontal drive signals.

5. A signal reading method for a solid-state image pickup apparatus including an image pickup section including a color separating section having color filters assigned to three primary colors R, G and B for separating colors of light incident from

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5 a desired scene, the color filters assigned to the color G being
arranged in stripes, a plurality of photosensitive cells arranged
bidimensionally in one-to-one correspondence to said color
filters each for transforming light output from a particular
color filter to a corresponding signal charge, and charge
10 sweeping circuitry for sweeping out needless ones of signal
charges stored in said plurality of photosensitive cells, said
image pickup section transferring the signal charges of said
plurality of photosensitive cells in a vertical direction and
then in a horizontal direction; said signal reading method
15 comprising the steps of:

(a) selecting, when an operation for reading the signal
charges out of said image pickup section is represented by a
mode, either one of an all pixel read mode for reading the signal
charges from all of said plurality of photosensitive cells and
20 a particular pixel read mode for reading only the signal charges
representative of the color G;

(b) generating drive signals for driving said image pickup
section in accordance with said all pixel read mode or said
particular pixel read mode selected;

25 (c) storing, in said particular pixel read mode, the signal
charges derived from the color G in response to said drive
signals while sweeping out the signal charges derived from the
colors R and B;

(d) effecting a field shift of only the signal charges
30 stored;

(e) vertically transferring the signal charges derived
from the color G and subjected to the field shift; and

(f) horizontally transferring the signal charges vertically
transferred at a period shorter than a period of time necessary
35 for the signal charges to be read out in said all pixel read
mode.

1 6. A method in accordance with claim 5, wherein step (b)

comprises:

(g) generating first drive signals for storing, in said particular pixel read mode, the signal charges derived from the color G while sweeping out the signal charges derived from the colors R and B;

(h) generating second drive signals for effecting the field shift;

(i) generating third drive signals for vertically transferring the signal charges subjected to the field shift; and

(j) generating drive signals for horizontally transferring the signal charges vertically transferred at a period shorter than a period of time necessary for the signal charges to be read out in said all pixel read mode.

ABSTRACT OF THE DISCLOSURE

1 A solid-state image pickup apparatus includes an image
pickup section. The image pickup section includes a color
separating section having color filters assigned to three primary
5 colors R (red), G (green) and B (blue) for separating colors
of light incident from a desired scene. The color filters
assigned to the color G are arranged in stripes. A plurality
of photosensitive devices or cells are arranged bidimensionally
in one-to-one correspondence to the color filters each for
10 transforming light output from a particular color filter to
a corresponding signal charge. A plurality of vertical transfer
paths each have transfer elements vertically arranged for
vertically transferring signal charges fed from the adjoining
photosensitive cells. A horizontal transfer path perpendicular
15 to the vertical transfer paths has transfer elements horizontally
arranged for transferring the signal charges fed from the
vertical transfer paths. Signal reading circuitry shifts the
signal charges from the photosensitive cells to the vertical
transfer paths. Charge sweeping circuitry sweeps out needless
20 ones of the signal charges stored in the photosensitive cells.
A mode selecting section selects, when the operation for reading
the signal charges out of the image pickup section is represented
by a mode, either one of an all pixel read mode for reading
the signal charges from all of the photosensitive cells and
25 a particular pixel read mode for reading only the signal charges
representative of the color G. A drive signal generating section
feeds horizontal and vertical drive signals to the image pickup
section, and provides the horizontal drive signals with a period
shorter in the particular pixel read mode than in the all pixel
30 read mode. A controller controls the drive signal generating
section in a particular manner in each of the all pixel read
mode and particular pixel read mode.

Fig. 1

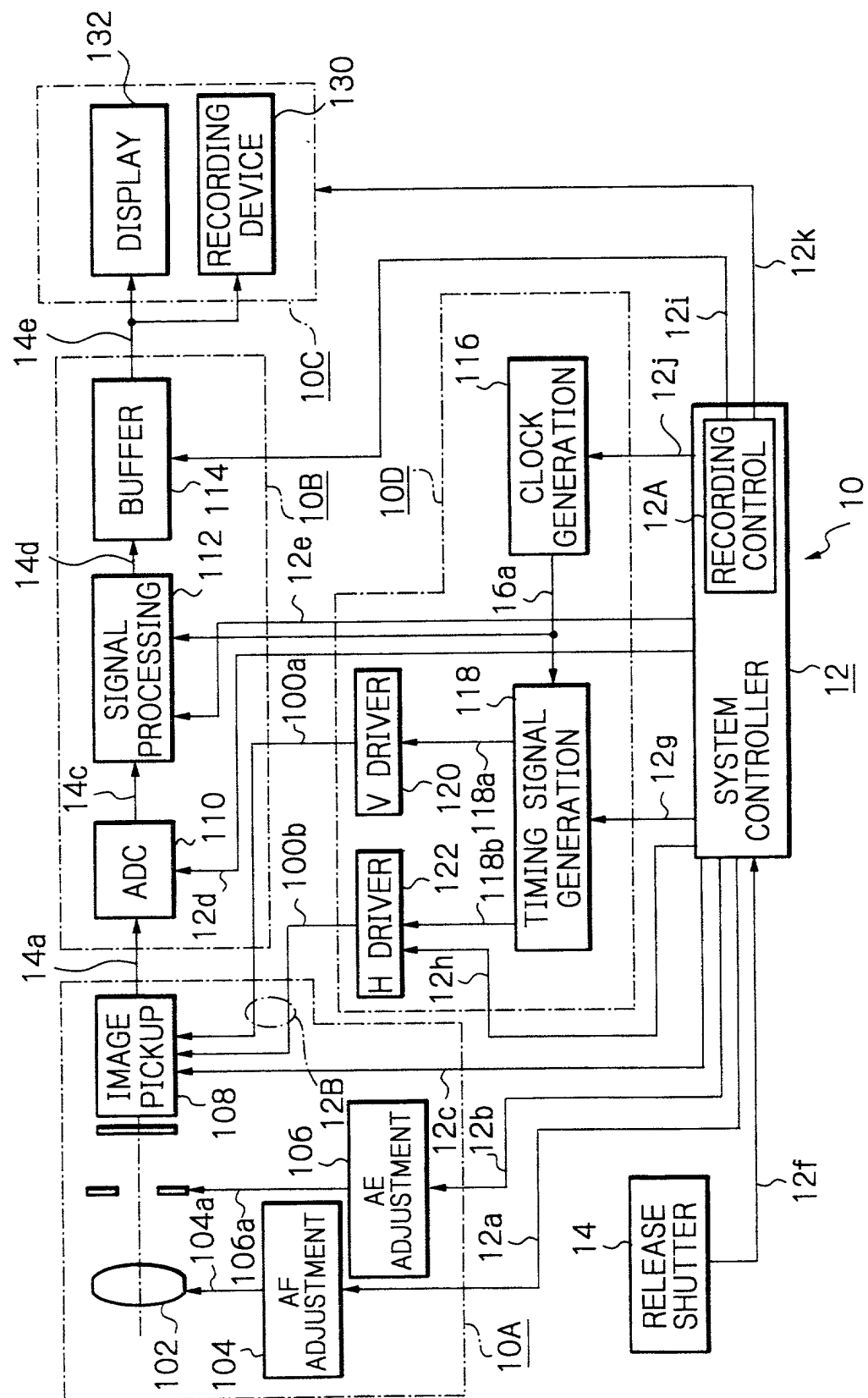


Fig. 2

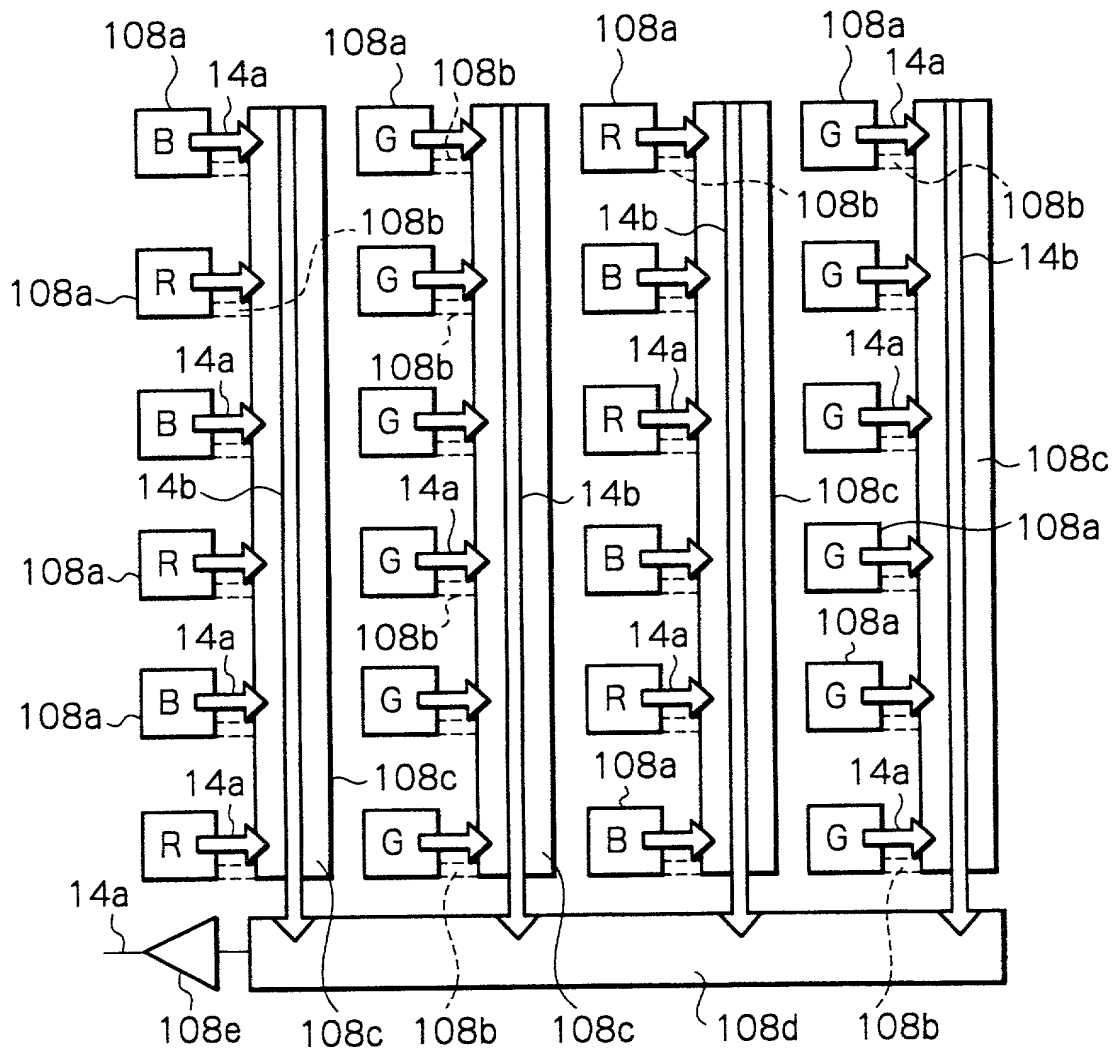


Fig. 3

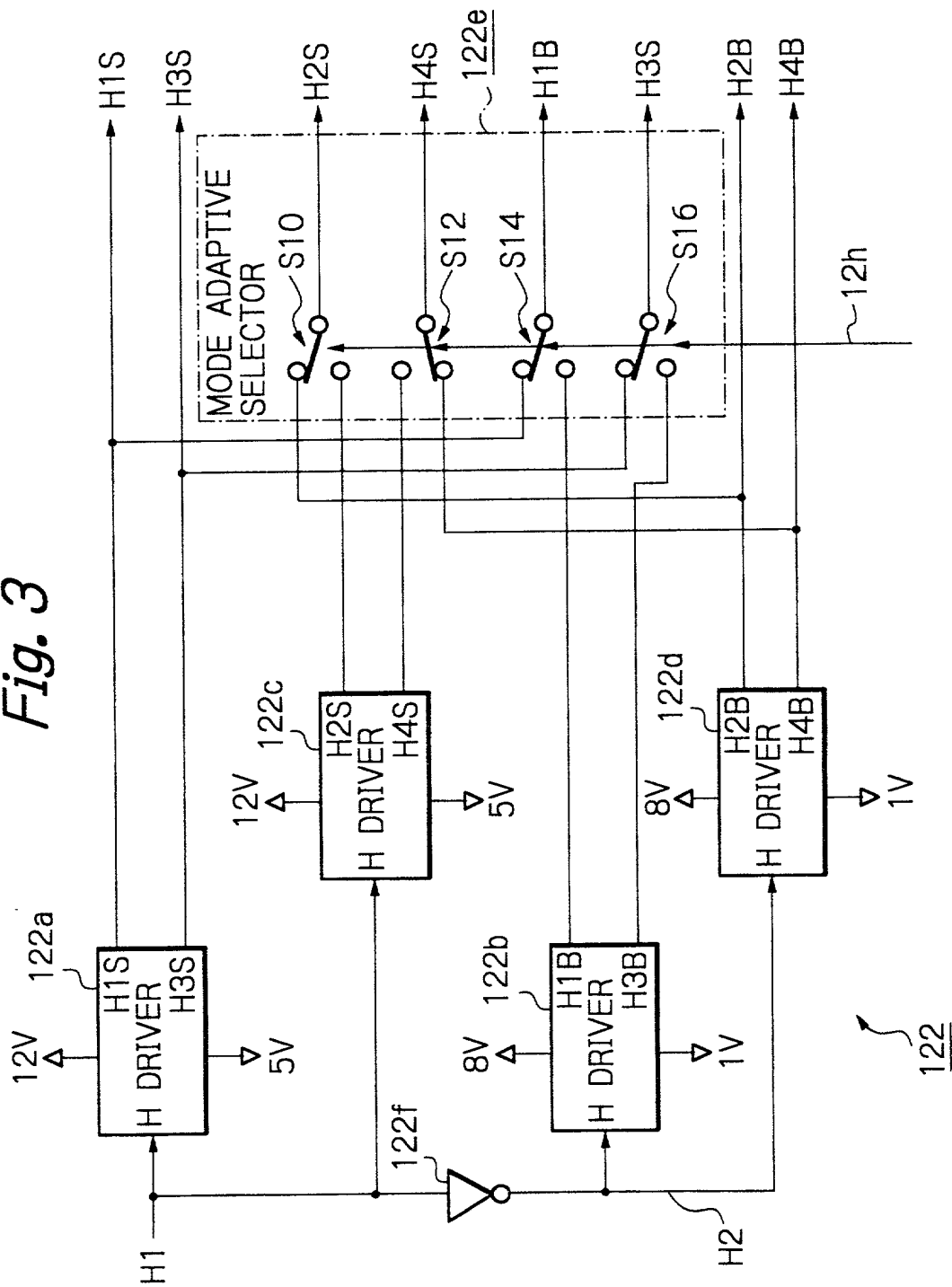


Fig. 4

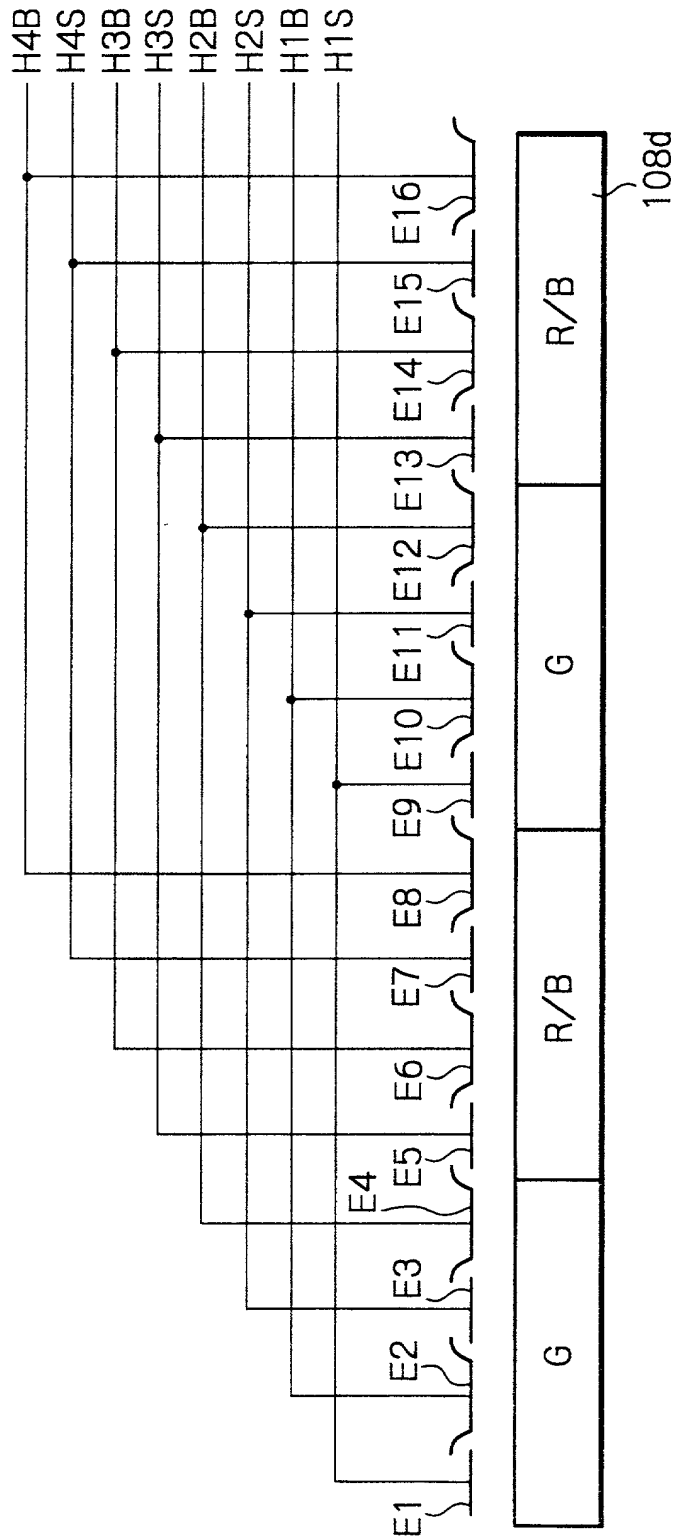


Fig. 5A

COLORS & DRIVE
SIGNAL
H1

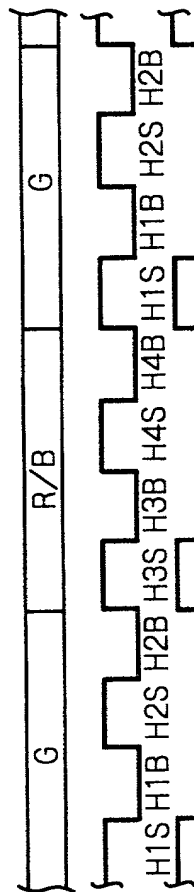


Fig. 5B

ALL PIXEL READ
DRIVE SIGNAL

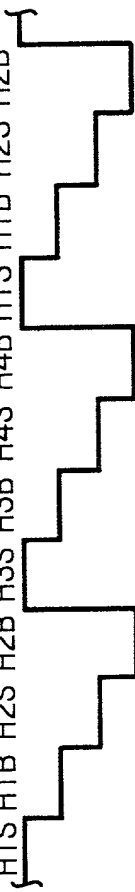


Fig. 5C

ALL PIXEL READ
DRIVE SIGNAL
(ANOTHER PATTERN)



Fig. 5D

H1S



Fig. 5E

H2S

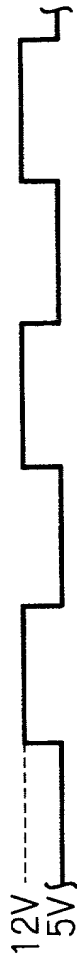


Fig. 5F

H1B



Fig. 5G

H2B



Fig. 5H

G SELECTION
DRIVE SIGNAL



Fig. 5I

G SELECTION
DRIVE SIGNAL

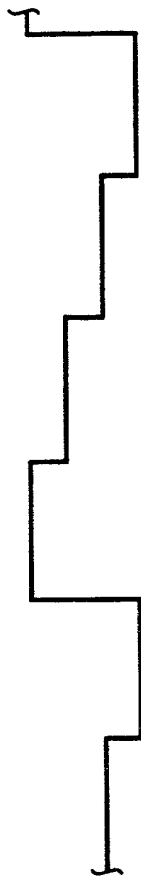


Fig. 6A

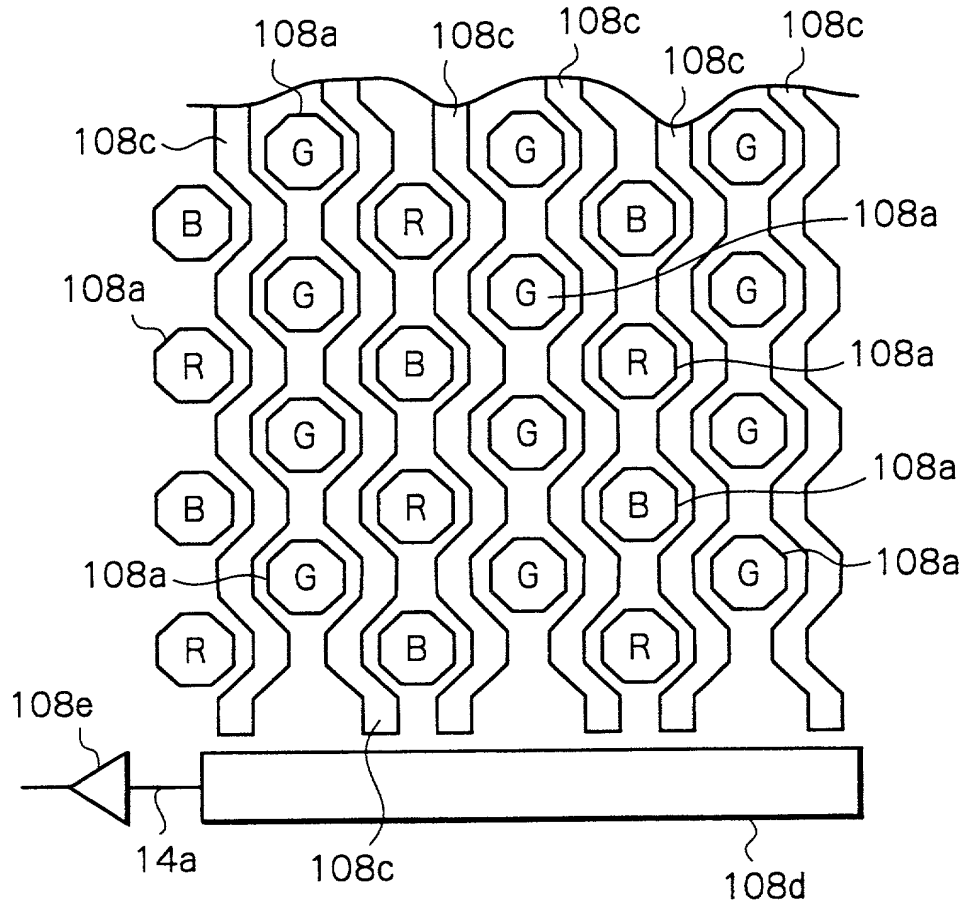


Fig. 6B

STILL PICTURE
SHOOT MODE

R	G	B	G	R	G	B	G
---	---	---	---	---	---	---	---

Fig. 6C

PHOTOMETRY
CONTROL MODE

	G		G		G		G
--	---	--	---	--	---	--	---

BIRCH, STEWART, KOLASCH & BIRCH, LLP

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ATTORNEY DOCKET NO.

378-361P

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As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated next to my name; that I verily believe that I am the original, first and sole inventor (if only one inventor is named below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

SOLID-STATE IMAGE PICKUP APPARATUS CAPABLE OF READING OUT
IMAGE SIGNALS WHILE THINNING THEM DOWN HORIZONTALLY AND
SIGNAL READING METHOD THEREFOR

the specification of which is attached hereto. If not attached hereto,

the specification was filed on _____ as
United States Application Number _____; and /or

the specification was filed on _____ as PCT
International Application Number _____; and was
amended under PCT Article 19 on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (six months for designs) prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as follows.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 (a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Insert Priority
Information:
(if appropriate)

Prior Foreign Application(s)

			Priority Claimed	
(Number)	(Country)	(Month/Day/Year Filed)	Yes	No
<u>315510/1998</u>	<u>Japan</u>	<u>November 6, 1998</u>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
_____	_____	_____	<input type="checkbox"/>	<input type="checkbox"/>
_____	_____	_____	<input type="checkbox"/>	<input type="checkbox"/>
_____	_____	_____	<input type="checkbox"/>	<input type="checkbox"/>
_____	_____	_____	<input type="checkbox"/>	<input type="checkbox"/>
_____	_____	_____	<input type="checkbox"/>	<input type="checkbox"/>

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(if any)

(Application Number)	(Filing Date)
_____	_____
(Application Number)	(Filing Date)

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Country	Application No	Date of Filing (Month/Day/Year)
_____	_____	_____
_____	_____	_____

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Insert Prior U.S.
Application(s):
(if any)

(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)
_____	_____	_____
(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)

I hereby appoint the following attorneys to prosecute this application and/or an international application based on this application and to transact all business in the Patent and Trademark Office connected therewith and in connection with the resulting patent based on instructions received from the entity who first sent the application papers to the attorneys identified below, unless the inventor(s) or assignee provides said attorneys with a written notice to the contrary:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Insert Date This
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POST OFFICE ADDRESS (Complete Street Address including City, State & Country)			
GIVEN NAME	FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Residence (City, State & Country)		CITIZENSHIP	
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